

2006 Public Health
Information Network
Conference



The California Public Health Information Network:
Architecture and Implementation of a Public Health Edge Server within
Hospital and Public Health Laboratories
A Case Study
<http://calip.ucdavis.edu>

Stuart Turner, DVM, MS
Biomedical Informatics Research & Consulting Service
Health Informatics Graduate Program
University of California, Davis

www.ucdmc.ucdavis.edu/bircs
www.ucdmc.ucdavis.edu/informatics



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Environment

Comment:

Policy, governance and security issues are inherently much more difficult to overcome in hospital vs. public health laboratories.

However, several hospitals, some large groups, clearly realize the importance of seeking standards based interoperability solutions, not just for reporting, but for other initiatives (e.g. RHIO's) as well.

California

Population: > 36 million (2005)

61 local health jurisdictions ranging from 1,100 people (Alpine County) to over 10,000,000 (Los Angeles)

Hospitals

~ 520 Hospitals

Target in initial phase:
First Receivers including trauma (adult and pediatric) centers or approximately 120 hospital laboratories

Three largest hospital groups comprised of ~ 40 (Catholic Healthcare West), 23 (Sutter Health) and 14 (Kaiser Northern California) labs with variable harmonization of laboratory infrastructure

Public Health Laboratories

39 Public Health Laboratories

Several leading LIMS vendors

One laboratory has no LIMS. Funding/procurement status prevents purchase of a LIMS, but allows the lab to build their own system. Another is uncertain about exposing data outside their local domain.

Most eager to receive support, training and hardware to realize interoperability with public health systems.

Business Documents

Defining the Relationship

- Reciprocal Confidentiality or Non-Disclosure Agreement
- Memorandum of Understanding (not a Business Associate Agreement)
- Service Level Agreement
- Public health agency policy and governance must be explicit, comprehensive and well crafted.
- Despite public health domain, hospitals remain very concerned about sharing data considered intellectual property (e.g. laboratory catalogs or knowledge of business practices).

Building the Team

- ▶ System engineers/administrators
 - ▶ Few do both Windows and Linux equally well.
- ▶ “Public Health Information Specialists”
 - ▶ Working directly with laboratory and laboratory information systems staff to gather and process test codes for translation to LOINC and SNOMED
 - ▶ Recruiting laboratorians (CLS, MT) was difficult. Final team comprised of physicians, veterinarians, and biomedical informaticists.
 - ▶ As learning curve began to stabilize, collaboration within and outside the group increased. Several found their “niche” (e.g. NLP, database design/schema, terminology development, etc.)

Workflow for laboratory test translation

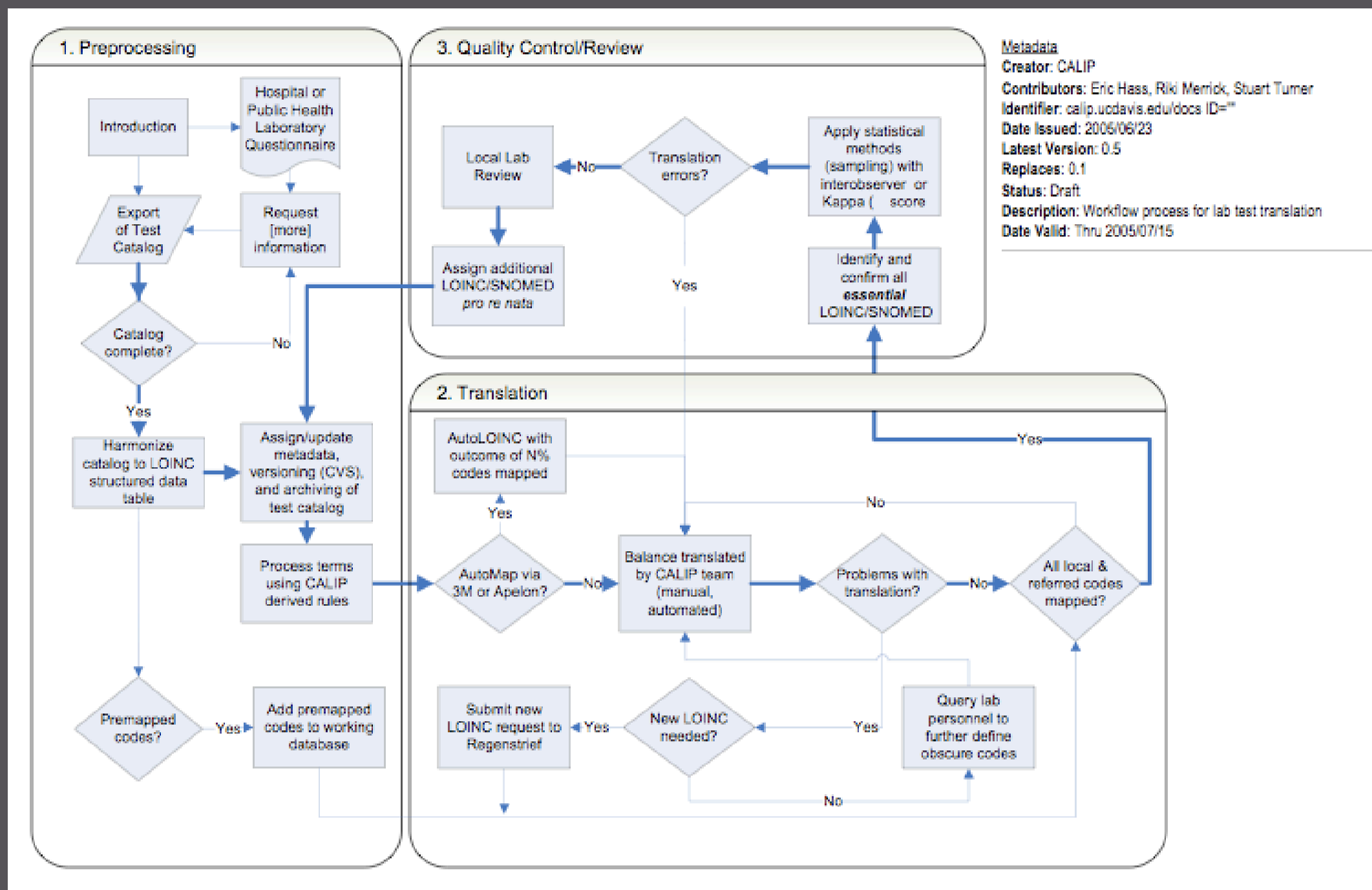
Normalization to a standard database structure (SAS) including LOINC classes

Natural Language Processing (stemming, tokenization, regular expressions, building queries)

Iterative data gathering and pre-processing from multiple sources (e.g. draw station DB for specimen type)

Terminology service partners (e.g. 3M Health Information Systems)

Lab catalogs varied from several hundred to around 15,000 test codes. Identifying which are “of interest” is challenging!



Requirements

Application Stack

Operating System: **Linux**
or Windows Server (~
80:20)

Database: PostgreSQL

HL7 Integration Engine,
Mapping and
Customization: Orion
Rhapsody and Orion
Symphonia

System Hardening:
Bastille Linux

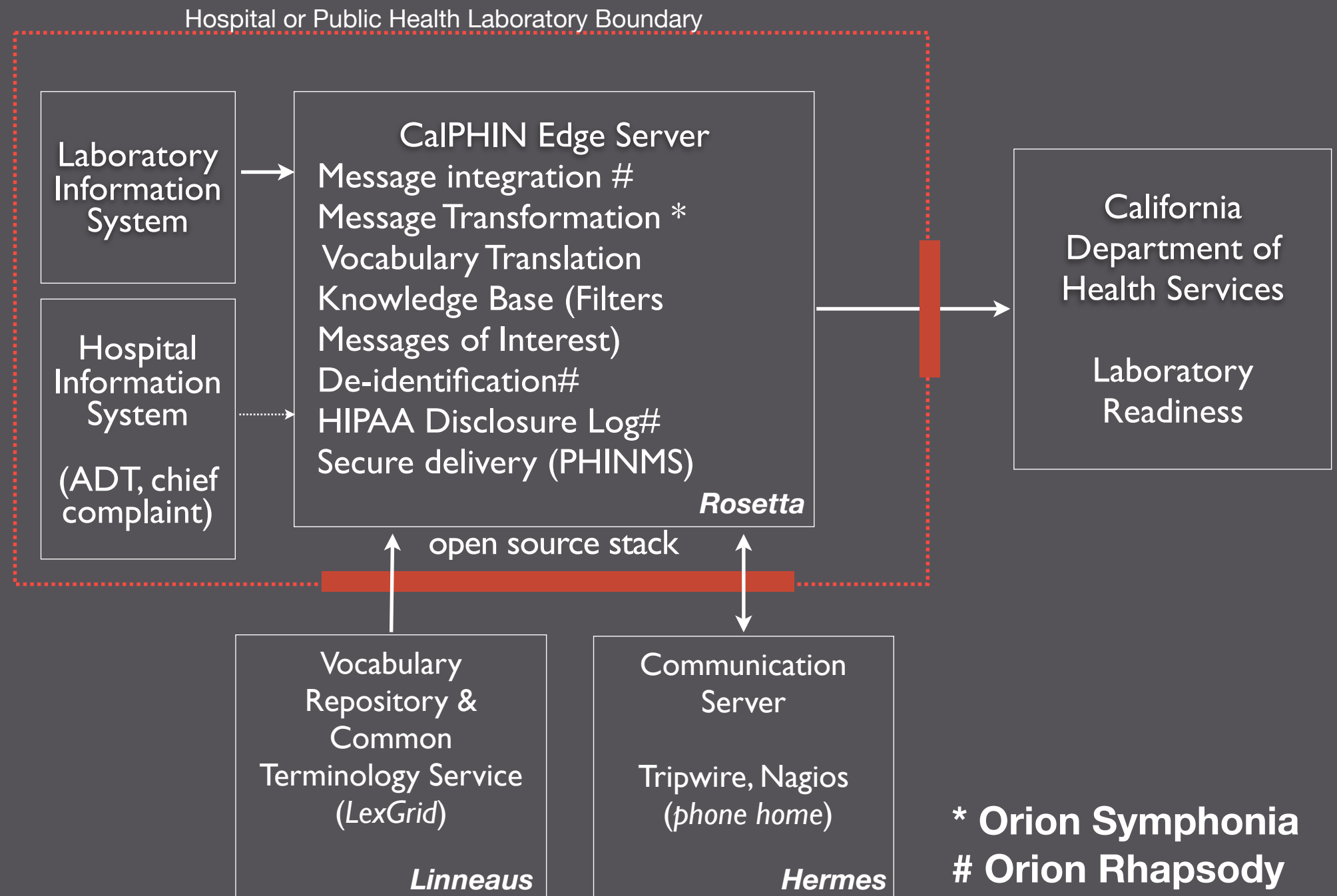
Antivirus: ClamAV

Security: Many (Nagios,
Snort, Tripwire)

Server hardware and application stack Objectives

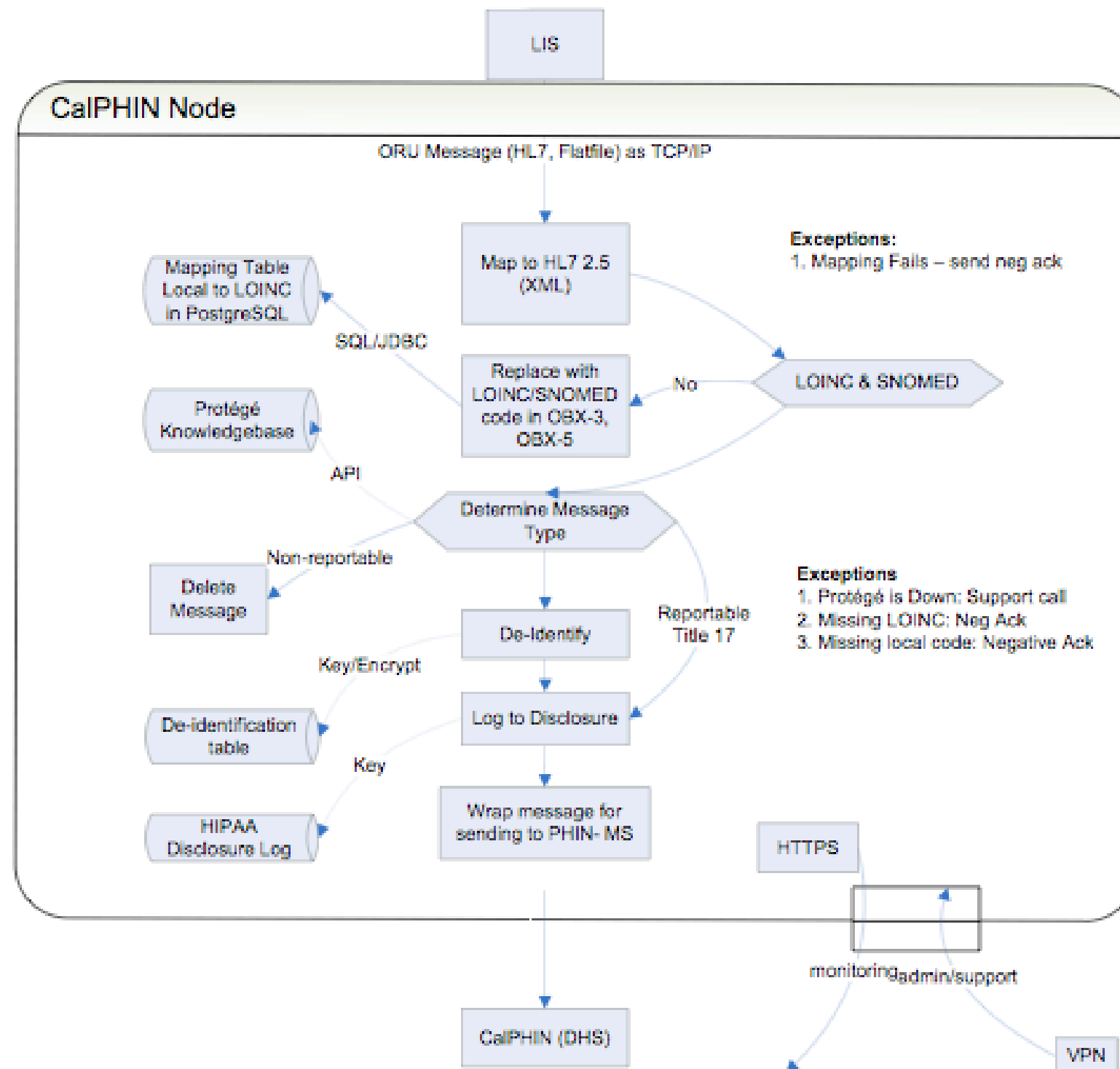
- Should be platform agnostic. Default application stack is **Linux** (Red Hat ES), Java Virtual Machine (JVM), **PostgreSQL** (database) and several open source security tools (e.g. Nagios). The knowledge base in the **Protege** Ontology Editor is not run as a service. The frame based knowledge is converted to a relational database
- Integration vendor, Orion Health, using **Orion Symphonia Mapper** and **Orion Rhapsody**, uses the Apache Tomcat web servlet container.
- Ease of remote management in a headless environment
- Design/architecture leverages as much enterprise-ready open source components and libraries as possible
- Strongly supported hardware (e.g. HP Proliant, Dell PowerEdge) with minimum lifecycle of 60 months.

Architecture: High Level



Edge Server Workflow

Edge Server Workflow



Collaborative
planning through
UML is essential.

Use Case
Diagrams and
Documents

Class Diagrams
(Object and
Logical Modeling)

Activity Diagrams

Deployment
Diagrams

Unified Modeling Language

eBed SRS.Use Cases - eBed Internal - Health Informatics/BIRCS Wiki

http://calip.ucdmc.ucdavis.edu/wiki/display/ebedpriv/eBed+SRS.Use+Cases#eBed laszlo

eBed SRS.Use Cases - eBed ...

Dashboard > eBed Internal > ... > eBed SRS.Use Case Suite > eBed SRS.Use Cases

eBed Internal

Welcome Stuart Turner | History | Preferences | Administration | Log Out

eBed SRS.Use Cases

View Edit Attachments (0) Info

Browse Space Add Page Add News

Added by Michael Resendez, last edited by Michael Resendez on Jan 13, 2006 (view change)

Labels: (None) EDIT

Use Cases

Release Information

Project:	eBed
Internal Release Number:	?.?.?
Related Documents:	Project proposal > User needs > Use Case Suite

Default Aspects of All Use Cases

Direct Actors:	User: end-user in any role System: The system being built When actors are not listed, assume User is doing it. Items beginning with "see" indicate that System has presented a new screen.
Stakeholders:	Project Owners and other members
Prereq:	User is logged in
Requirement:	Invalid data causes the user to be reprompted for valid data; a hint should be provided

UC-01 Add Facility

Summary:	A new facility is added to the system; A facility is also called a hospital
Priority:	Fundamental
Use Frequency:	Fairly infrequent after initial setup
Main Success Scenario:	1. user visits facility mangement page 2. user selects 'add facility' 3. user enters facility data 4. user selects submit 5. user views confirmation
Alternative Scenario Extensions:	•
Notes and Questions	• What is a valid facility name?

UC-02 Modify Facility Attributes

Summary:	Basic facility attributes, such as name, can be edited directly. Other attributes, such as units, etc, are edited through the corresponding page
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http://calip.ucdmc.ucdavis.edu/wiki/display/ebedpriv/eBed+QA+Plan.Test+Suite laszlo

eBed QA Plan.Test Suite - e...

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Automated report printing	N/A	N/A	N/A	N/A	TC-174
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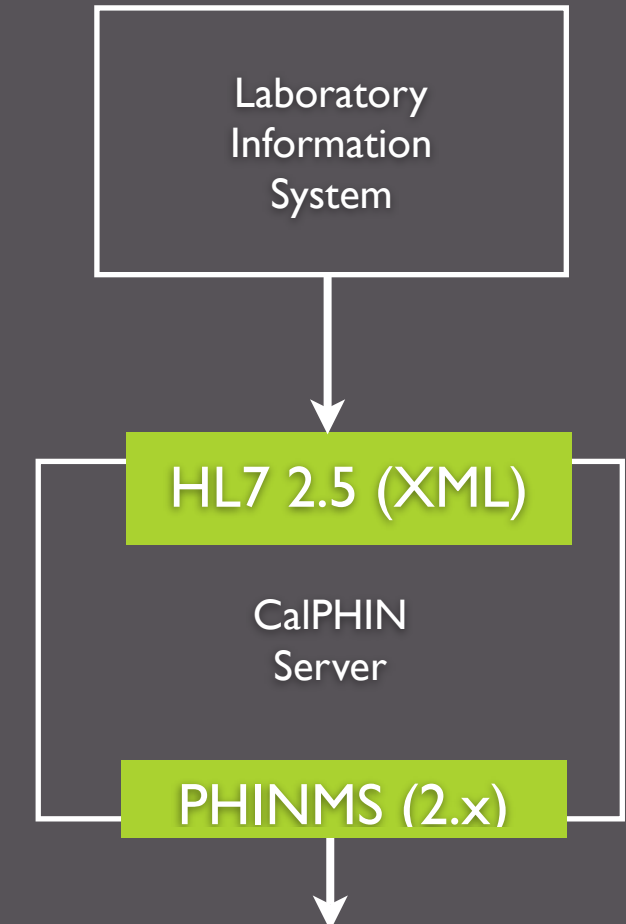
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 - F-22 Assign Facility to Group (GroupLink) :** [TC-50](#) User assigns Facility to existing Group.
 - F-23 Remove Facility From Group :** [TC-51](#) User removes Facility from Group, [TC-52](#) User cancels the deletion of facility from Facility Group.

Requirements

Syntactic Interoperability

- Message transformation
 - Most labs were able to send an HL7 message. Versions and implementations were widely variable. Documentation was often of little value. A set of sample (but representative) messages was best method to perform mapping.
 - All messages mapped immediately to HL7 2.5 (Orion Symphonia) in XML, despite what target application required, before messages were processed further.
 - Message transformation relatively trivial. Properly populating the message from the laboratory information system was not (next)



Requirements

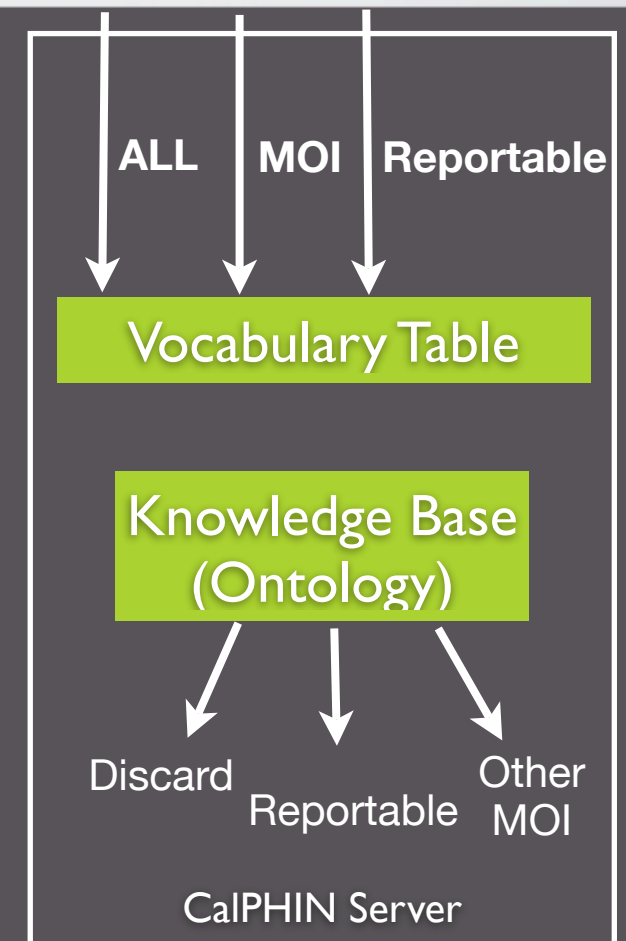
Semantic Interoperability: Messages of Interest

MOI: Messages of Interest

Any message intended for public health reporting either as a legally mandated reportable messages, an additional message for ad hoc reporting or surveillance, or a message intended for other use cases (e.g. RHIO, bed capacity, etc.)

This is distinguished from “reportable” messages which more clearly refer to those falling under legislation - or Title 17 Section 2505 in California

- Knowledge base, developed as an ontology (Dr. Cecil Lynch) created to filter messages of interest.
- Receiving properly mapped (LOINC/SNOMED) messages was one of the most difficult challenges. Many LIS were unable to populate these additional data elements without redevelopment as a separate object class/attribute pair or a entity/relation in their native databases. Therefore, mapping (vocabulary) tables maintained in the server
- LIS ability to filter for Messages of Interest (MOI) or legally reportable messages was unreliable. The knowledge base allowed for message interrogation (OBX-3, LOINC) and subsequent parsing.

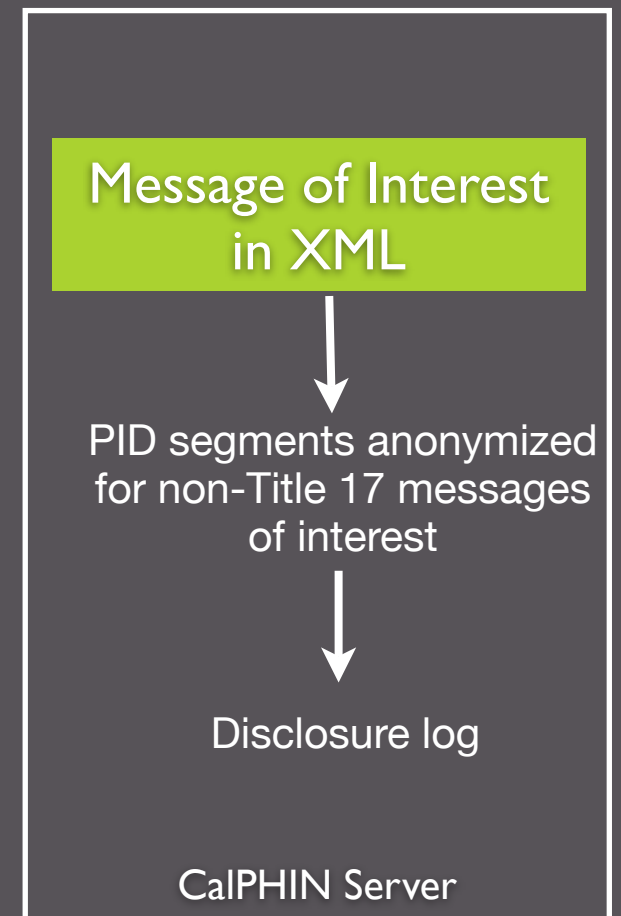


De-identification HIPAA Disclosure log

Disclosure log:

We discovered that most systems had no method of processing an electronic disclosure log. In general, IT staff had to refer to a HIPAA compliance officer (or other) for advice on methods of archival (e.g. frequency, duration, location, etc.)

- Although the core implementation required submitting reportable messages currently required by law in California under Title 17 that intrinsically should not be anonymized, the intent of the architecture was to be extensible for all public health message use cases. This is especially true for hospitals (e.g. ADT, chief complaint, bed capacity, patient record summaries, etc.)
- De-identification on an HL7 message was relatively trivial (PID segment).
- LIS ability to filter for Messages of Interest (MOI) or legally reportable messages was unreliable. The knowledge base allowed for message interrogation (OBX-3, LOINC) and subsequent parsing.



Semantic Interoperability

Requirements Gathering Server

- IT network topology and security analysis.
- Obtain VPN access agreements and tokens.
- Procure, build, test, ship, rack, network, configure CalPHIN application server.
- Obtain message specifications (HL7, flat file) and sample messages.
- Complete integration of vocabulary tables (LOINC/SNOMED) into application server
- Build transformation scripts (Orion Symphonia).
- Orion Rhapsody team builds configuration scripts or “communication points” based on local requirements. Local (UC Davis) Rhapsody engineer works with Orion to further customize scripts and manage the routes.
- Test the route (unit, regression, communication testing, data validation with phantom target).
- Security analysis
- CALIP assesses PHIN certification steps.

Collaboration

Web-based, mostly
open source
communication
tools

Enterprise
Customer Relation
Management
Application
(SugarCRM)

SugarCRM - Commercial Open Source CRM

http://calip.ucdavis.edu/contacts/index.php?action=DetailView&module=Accounts&record=1a30c9e7-f6d6

[sugar] News (235) system76 Metadata Disease Ontology

Icon	Subject	Type	Author	Organization	Date	Actions
📅	Sutter Rhapsody Reconciliation	Meeting Held		Sutter Health System (primary)	2005-11-08 12:07	edit del
📧	11 NOV 2005 Meeting Agenda	Email	Brian Johnson	Sutter Health System (primary)	2005-11-08 11:03	edit del
📧	[CALIP]ftpting the Box	Email	Brian Johnson	Sutter Health System (primary)	2005-11-01 17:22	edit del
📝	conversation re ftp to box	Note	Stephen Nesbitt, PMP	Sutter Health System (primary)	2005-11-01 17:02	edit del
📝	re Rhapsody and VPN explained	Note	Brian Johnson	Sutter Health System (primary)	2005-11-01 16:47	edit del
📧	[CALIP]re questions on test server and allergy tests	Email	Stephen Nesbitt, PMP	Sutter Health System (primary)	2005-11-01 16:27	edit del
📝	re test route and questions on allergen reporting	Note	Stephen Nesbitt, PMP	Sutter Health System (primary)	2005-11-01 16:20	edit del
📝	rhapsody remote management problems	Note	JD Sampson	Sutter Health System (primary)	2005-11-01 10:56	edit del
📧	[CALIP]	Email	Stephen Nesbitt, PMP	Sutter Health System (primary)	2005-11-01 10:52	edit del
📧	[CALIP]Questions on the test catalog and update on server	Email	Stephen Nesbitt, PMP	Sutter Health System (primary)	2005-10-31 15:00	edit del
📧	[CALIP]re difficulty with access to box	Email	Brian Johnson	Sutter Health System (primary)	2005-10-27 10:55	edit del
📧	[CALIP]Orion's difficulty in accessing the LINUX box	Email	Brian Johnson	Sutter Health System (primary)	2005-10-27 10:30	edit del
📝	VPN account info fro server	Note		Sutter Health System (primary)	2005-10-25 14:01	edit del
📅	Install Server 1	Task Completed		Sutter Health System (primary)	2005-10-24	edit del
📅	map shs t17	Task Completed		Sutter Health System (primary)	2005-10-24	edit del

📁 **Contacts**

Create Select

Contact Name	Account Name	Email Address	Phone	Actions
Michele Leonard	Sutter Health System (primary)	LeonarM1@sutterhealth.org	916.286.8274	edit del
Stephen Nesbitt, PMP	Sutter Health System (primary)	nesbits@sutterhealth.org	916.454.8520	edit del
Jonathon Taylor	Sutter Health System (primary)	taylorje@sutterhealth.org	916.454.8348	edit del
Jean Bowman	Sutter Health System (primary)	BowmanJ@sutterhealth.org		edit del
Lewis Gasper	Sutter Health System (primary)	GasperL@sutterhealth.org		edit del
Bruce Peterson	Sutter Health System (primary)	petersb@sutterhealth.org	916.733.8800	edit del
Fred Michel	Sutter Health System (primary)	MichelFA@sutterhealth.org		edit del

📁 **Member Organizations**

Create Select

Account Name	City	Phone	Actions
Memorial Medical Center	Modesto, CA	209-526-4500	edit rem
Eden Medical Center	Castro Valley, CA		edit rem
Alta Bates Summit Med Center - Herrick Campus	Berkeley,		edit rem
Alta Bates Summit Med Center-Alta Bates Campus	Berkeley,		edit rem
Alta Bates Summit Med Center-Summit Campus-Hawthorne	Oakland,		edit rem
Alta Bates Summit Med Center-Summit Campus-Summit	Oakland,		edit rem
California Pacific Med Center-California East	San Francisco,		edit rem
California Pacific Med Center-California West	San Francisco,		edit rem
California Pacific Med Center-Davies Campus	San Francisco,		edit rem
California Pacific Med Center-Pacific Campus	San Francisco,		edit rem
Laurel Grove Hospital	Castro Valley,		edit rem
Marin General Hospital	Greenbrae,		edit rem
Memorial Hospital Los Banos	Los Banos,		edit rem

Collaboration

Most successful communication tool has been the Wiki.

Project evolved from use of several open source Wiki's (e.g. Wikimedia) to an enterprise commercial offering (Atlassian Confluence).

This decision was mostly based on robust permissioning that was not available in open source versions as well as integration in to an issue tracking application (Atlassian JIRA)

eBed SRS.Use Cases – eBed Internal – Health Informatics/BIRCS Wiki

http://calip.ucdmc.ucdavis.edu/wiki/display/ebedpriv/eBed+SRS.Use+Cases#eBed

laszlo

eBed SRS.Use Cases – eBed Internal

Dashboard > eBed Internal > eBed SRS.Use Case Suite > eBed SRS.Use Cases

eBed Internal

Welcome Stuart Turner | History | Preferences | Administration | Log Out

View

Edit

Attachments (0)

Info

Browse Space

Add Page

Add News

Added by Michael Resendez, last edited by Michael Resendez on Jan 13, 2006 (view change)

Labels: (None) EDIT

Use Cases

Release Information

Project:

eBed

Internal Release Number:

?.?.?

Related Documents:

[Project proposal](#) > [User needs](#) > [Use Case Suite](#)

Default Aspects of All Use Cases

Direct Actors:

User: end-user in any role
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Invalid data causes the user to be reprompted for valid data; a hint should be provided

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Summary:

A new facility is added to the system; A facility is also called a hospital

Priority:

Fundamental

Use Frequency:

Fairly infrequent after initial setup

Main Success Scenario:

1. user visits facility mangement page

2. user selects 'add facility'

3. user enters facility data

4. user selects submit

5. user views confirmation

Alternative Scenario Extensions:

Notes and Questions

• What is a valid facility name?

UC-02 Modify Facility Attributes

Summary:

Basic facility attributes, such as name, can be edited directly. Other attributes, such as units, etc, are edited through the corresponding page

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Test Cases by Feature Priority

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UCDAVIS
UNIVERSITY OF CALIFORNIA

BIRCS: Biomedical Informatics Research & Consulting Service
University of California Davis Health System

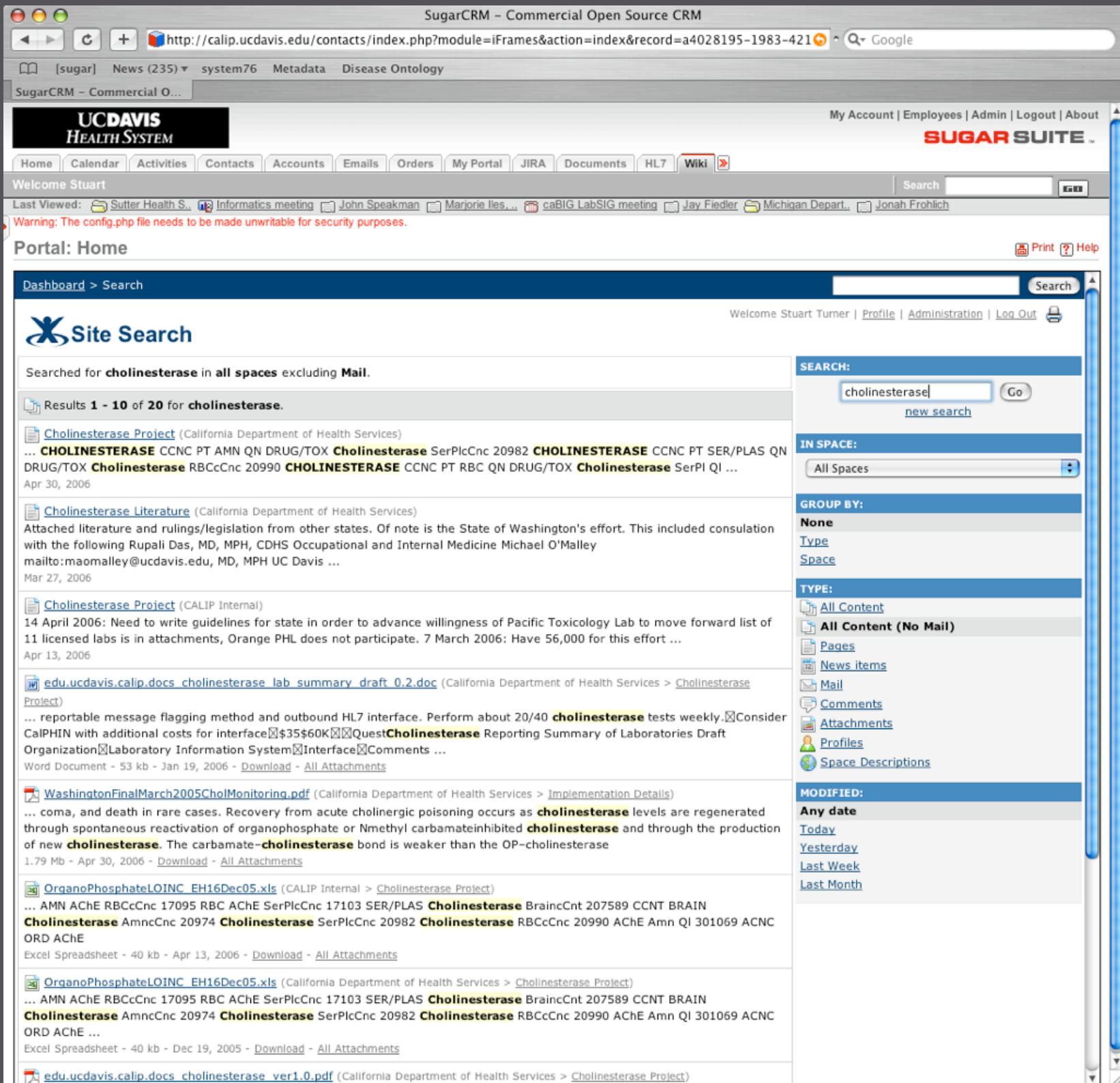
15

Collaboration

Online tools allowed staff to update content from anywhere.

Fully searchable.

Documents, meeting agendas, internal memos, etc.



Collaboration

Project Management Issue/Feature Tracking

The screenshot displays the SugarCRM interface, which is integrated with JIRA for project management. The browser address bar shows the URL: <http://calip.ucdavis.edu/contacts/index.php?module=iFrames&action=index&record=a6101254-8d75-7ed>. The page header includes the UC Davis Health System logo and the Sugar Suite branding. The navigation bar contains links for Home, Calendar, Activities, Contacts, Accounts, Emails, Orders, My Portal, JIRA, Documents, HL7, and JIRA. The sidebar on the left provides 'Issue Details' for the selected issue (EBED-34), including its type (Task), status (Open), priority (Minor), assignee (Michael Resendez), and reporter (Michael Resendez). It also lists 'Available Workflow Actions' such as Resolve Issue, Close Issue, Assign, Clone, Comment, Create sub-task, Delete, Edit, Link, Move, Voting, Watching, and Worklog. The main content area shows the issue title 'Reconfigure CruiseControl so that automatic unit & integration testing occurs.' and its description: 'CruiseControl, the automatic unit testing wrapper running on RedBat, needs to be reconfigured. There are a number of issues relating to class paths and munged variable names that need to be resolved in the build.xml.' The issue is assigned to Michael Resendez and has a remaining estimate of 5 hours and 30 minutes. A sub-task list is visible, showing one sub-task: 'Configure Postgres testing database on RedBat'.

Collaboration

Asset Tracking

All server information including contacts, configuration files, software licenses, etc.

IRM: Computers - Info

http://calip.ucdavis.edu/irm/users/computers-info.php?ID=15

[sugar] News (235) system76 Metadata Disease Ontology

IRM: Computers - Info

Computers | Networking | Software | Tracking | FastTrack | Reports | Request Help | Setup | Preferences | Knowledge Base | FAQ | Logout May 04 03:30

Computers

- Servers - External
- Servers - Internal
- Servers - Rack
- Servers - Tower
- Workstations - Desktop
- Workstations - Laptop
- Not grouped
- Add computer...
- Manage groups...
- Network
- Software
- Tracking
- Reports
- Knowledge Base
- FAQ
- Setup
- Preferences

Computers - Info

Sutter 1 (15) Add Tracking

Name: Sutter 1 Type: HP Proliant DL360

Location: Sutter Data Center (Mather) OS: Linux (RedHat)

OS Version: ES ver Processor: Intel Xeon

Processor Speed: 3.4GHz Serial Number: S/N USE528C3LD

Other Serial Number: PID 3670070-405 Hard Drive Space (in gigabytes):

RAM Type: ECC DIMMs RAM Amount (in GB): 2000

Network Card Brand/Type: Intel (100Mbps) IP Address: 10.141.45.64

MAC/Network Address:

Comments: Updated by Sutter
The hostname is:
accounts set up by Sutter
Kilkolly, Grant vvKikoG
Zaheer, Omer vvZaheO
Haas, Eric vvHaasE

IT Contact Person: Brian Johnson Contact Number: 916-454-8285

Flags: ☒ Server (constantly running)
☐ Surplus

Last Updated: 2005-11-08 12:05:40

Update Delete

Port #	Name	Interface	IP Address	MAC/Network Address	Connected to...
1	Port 1	100Base FL			Nothing Connected. Connect

[Add Port](#)

No Tracking Found

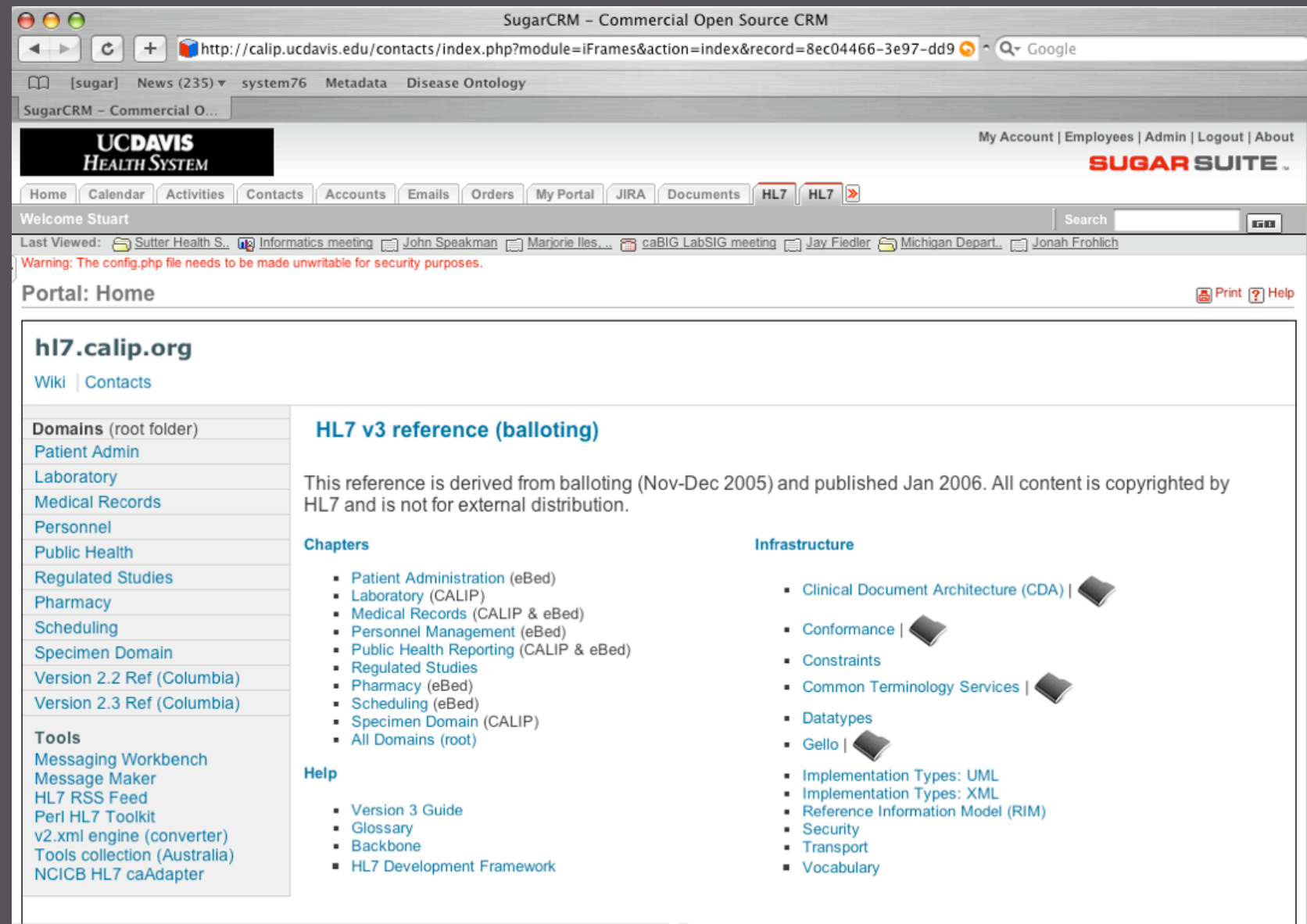
Installed Software

Software	License(s)	Action
Red Hat Linux ES, 1 license(s).	703674	[Delete]
Add software Adobe Acrobat 7.0 to computer, using 1 license(s).		Add

Reference Information

All important reference or standards documentation or other links to papers were kept within the same portal.

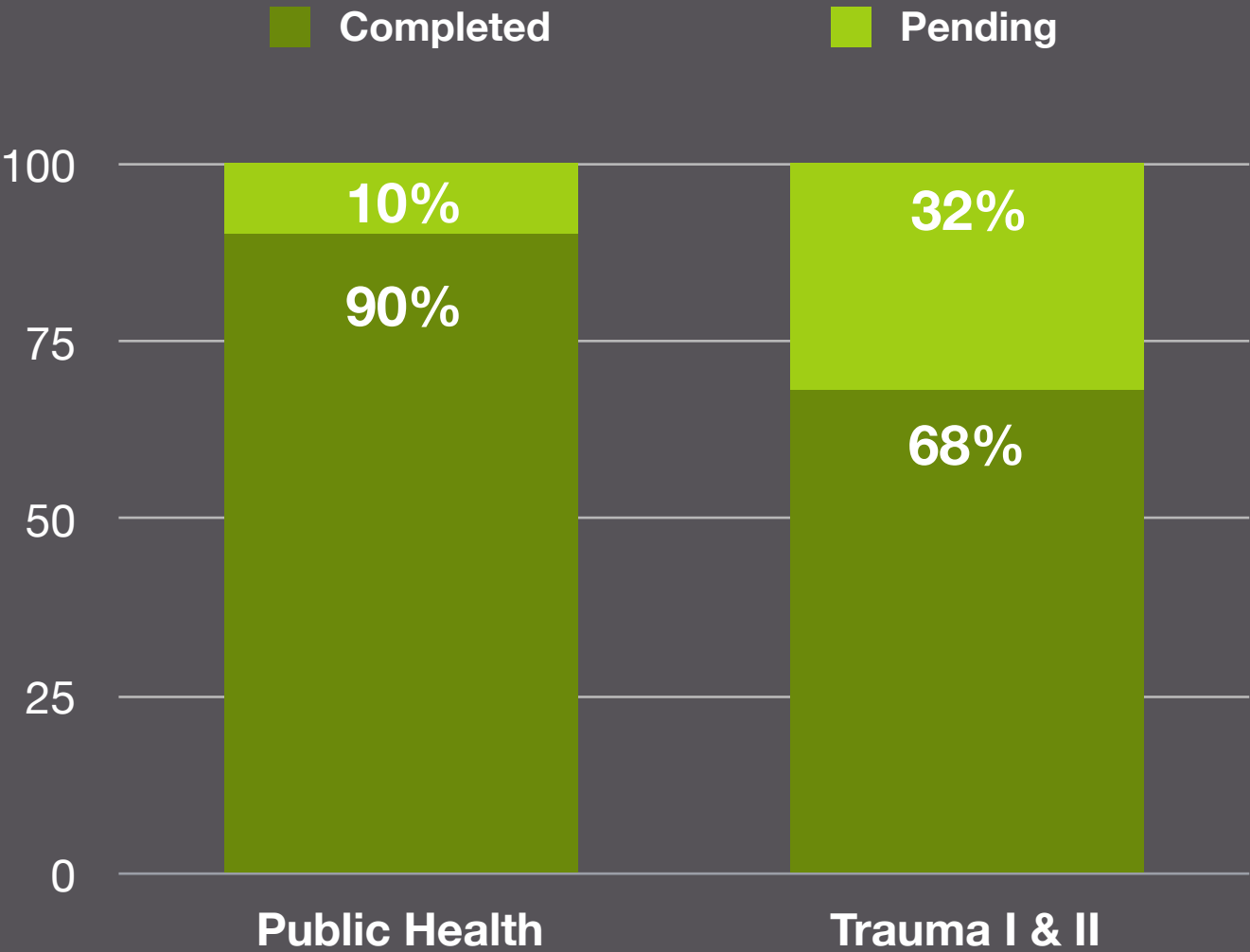
This includes links to files as well as a Document Management System that allowed inclusion of metadata (Dublin Core) to facilitate searching.



California
Laboratory
Integration

Year 1

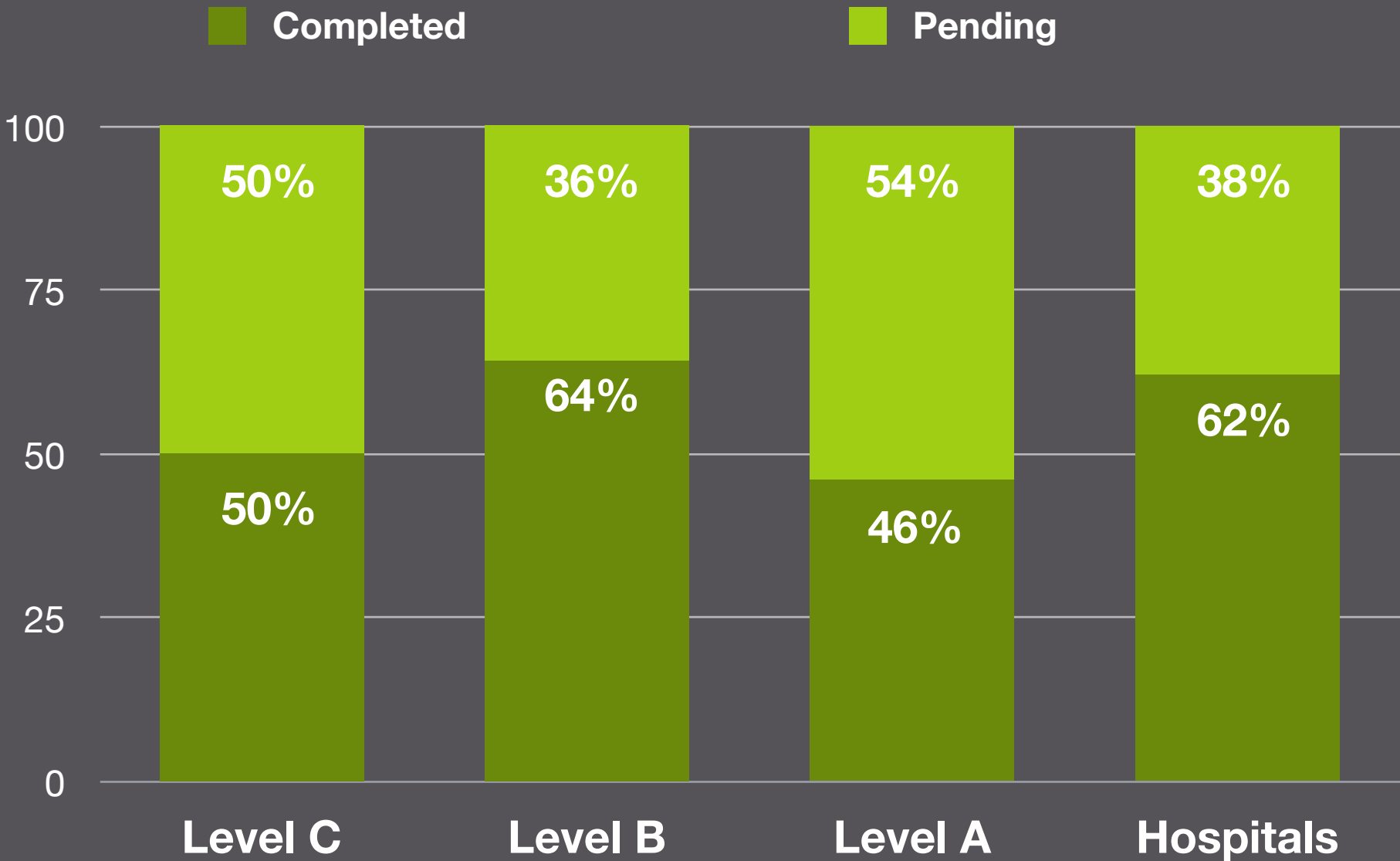
Engagement
of active laboratory partners



California Laboratory Integration

Year 1

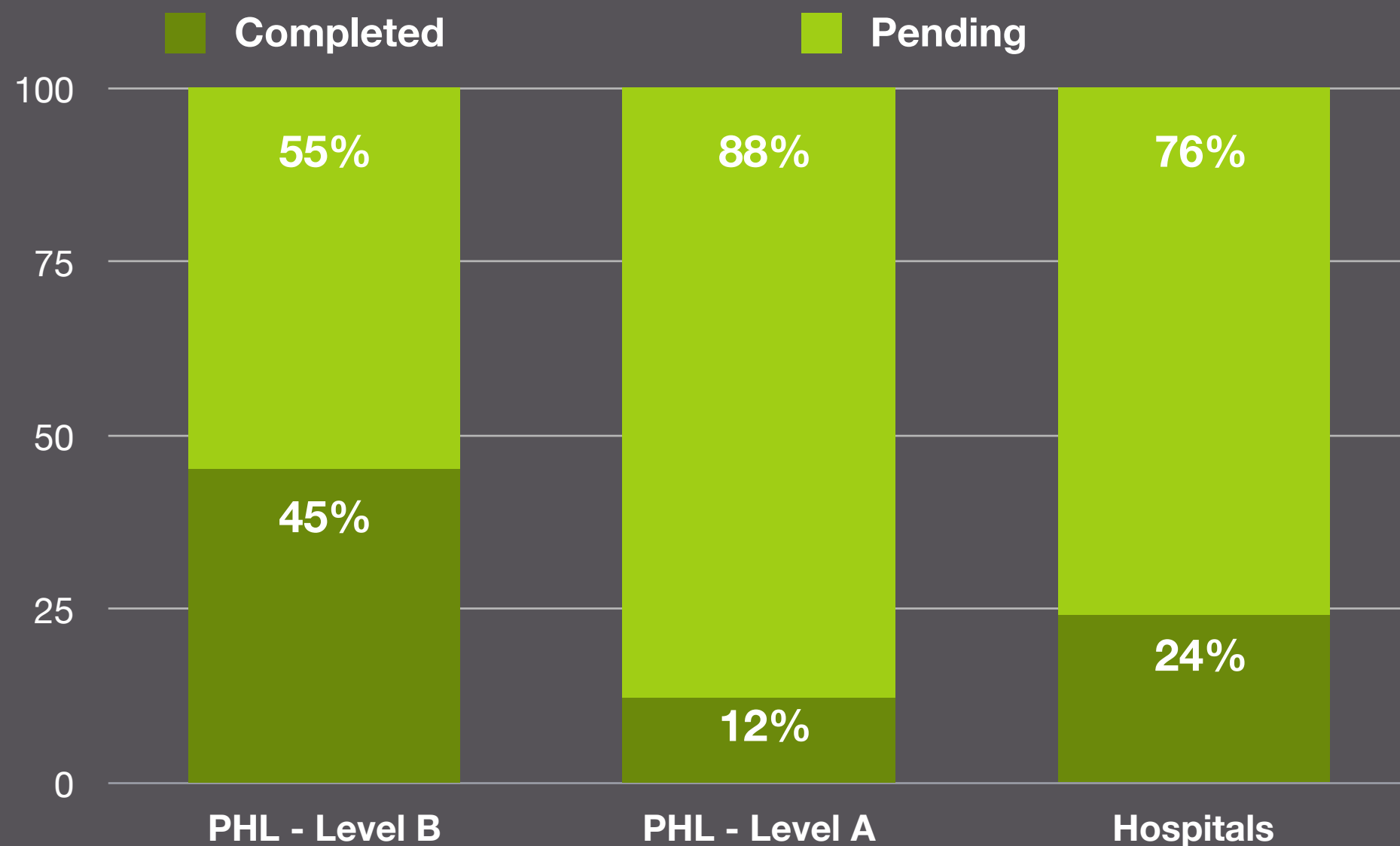
Vocabulary/Terminology Services



**California
Laboratory
Integration**

Year 1

CalPHIN Servers



Objectivist and Subjectivist Evaluation Processes

- ■ Objectivist
 - ■ Comparison-based (implementations in other states). Similar process to random controlled studies in clinical research
 - ■ Objectives-based: Has the implementation met expectations (Were there expectations?)
 - ■ Decision-Facilitation (Formative process designed to answer questions important to developers ; evaluate alternatives)
- ■ Subjectivist
 - ■ Professional review
 - ■ Responsive/Illuminative (interviews with all prototypical users including laboratorians, hospital administrators, public health personnel, patients)

Lessons learned

- Policy (governance) first
- Thorough planning including formal and shareable modeling processes (UML)
- Integration of end-users (hospital and public health laboratories) into a pervasive open collaboration environment
- Be firm and progressive regarding syntactic and semantic interoperability.
- Iterative review and evaluation. Be agile. Waterfall methodology dangerous given the timeframe



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CALIP Project Staff
University of
California, Davis

Questions?

Stuart Turner
swturner@ucdavis.edu
<http://calip.ucdavis.edu>